Institute for Materials Science

Institute for Materials Science Lecture Series

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Solute Enhanced Strain Hardening of Aluminum Alloys for Higher Strength / Toughness Combinations

Wednesday, May 6, 2015

1:15 - 2:15 PM

TA-03, Bldg. 1698, Room A103 (MSL Auditorium)

Abstract: When the yield strength of metallic alloys is increased the fracture toughness almost always falls. By use of a plot of *bond strength normalized* fracture toughness ($K_{IC}/(Ey)^{1/2}$) as a function of equivalently normalized yield strength (σ_{YS}/G) it had been previously shown (Shaji et al.) that a strain hardened Co-Ni-Cr-Mo (fcc) alloy (MP35N) had better combinations of normalized strength and toughness than the best precipitation hardened (fcc) Al alloys. Previous work (Vasudevan and Doherty) had previously confirmed that precipitation hardened aluminum Al-Li alloys showed a steady *fall of fracture toughness,* at the same yield strength, as the area fraction of *grain boundary particles* was increased. Prior work (Doherty and McBride) had also confirmed that aluminum alloys with high levels of Cu, Mg, Zn, Si, *in solution* showed greatly enhanced *strain hardening*. With strain hardening in such alloys, grain boundary precipitation can be avoided. After briefly reviewing these back ground results, the present study will be described to show that a modern Al-Cu-Mg alloy (2524), after solution heat treatment, could be given *greater strength* at similar fracture toughness levels to the standard precipitation hardening treatment (T6). This was achieved by avoiding significant *Grain Boundary Particles*, inevitable in precipitation treatments, while obtaining, by solute-enhanced, strain hardening alloys with enhanced strength. This model was confirmed by fractography where the precipitation hardened alloys showed *intergranular* fracture, with finely spaced dimples, while the strain hardened alloy showed ductile *transgranular* fracture with coarser dimples.

Biography: Roger Doherty received his D. Phil. from Oxford University in 1964, worked for two years in the UK steel industry and then spent 17 years first helping found and finally having to close the Materials Science "Subject Group" in the Engineering School at Sussex University in the UK. In 1982 he joined Drexel University and remained there until his retirement, then becoming an Emeritus Professor, in 2008. He became a US citizen in1988. Time has been spent as a Technical Advisor in the Brazilian Air Force Research Center in Sao Paulo, a Guest Professor at the Delft Technical University in the Netherland and for sabbaticals at the Norwegian Technical University in Trondheim, Norway, at the Riso Research Center in Denmark and at the School of Mines in St. Etienne France. He has consulted for various research organizations, most extensively for Alcoa Technical Center. Recently, he has been a Visiting Professor at IIT-Bombay, India. His research interests are in the processing, microstructure and properties of metallic alloys most particularly those of aluminum. A central activity in this work has been trying to understand the mechanisms of structural changes including those of solidification, solid state phase transformations, recrystallization and grain growth. He has advised or co-advised over 40 PhD students and published over 200 papers and review articles and co-authored two textbooks. A major pleasure is in meeting with young investigators to learn about new developments in these topics.

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